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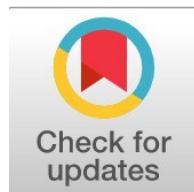
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Lean Manufacturing to Reduce Waste in Jumbo Bag Production Using VSM, VALSAT, Kaizen

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Abstract

General Background The manufacturing industry is under constant pressure to optimize production processes and maintain product quality. **Specific Background** PT ABC, a manufacturer of jumbo bags, faces operational inefficiencies, including a high volume of defective units and a significant lead time of 515 minutes, resulting in a low Process Cycle Efficiency (PCE) of 54.37%. **Knowledge Gap** Many existing studies treat lean tools such as Value Stream Mapping (VSM), Value Stream Analysis Tools (VALSAT), and Kaizen as isolated methods, failing to provide an integrated framework that quantifies efficiency through quantitative indicators like PCE. **Aims** This study integrates VSM, VALSAT, Process Activity Mapping (PAM), and Kaizen principles to identify, prioritize, and mitigate critical waste within the jumbo bag production flow. **Results** The analysis identifies waiting and motion as the most dominant waste categories. Proposed Kaizen-based initiatives—including implementing start-up checklists, standardizing work sequences, and reorganizing workstations—successfully reduce the total lead time to 420 minutes, while projected PCE increases to 66.67%. **Novelty** This research introduces a structured, integrated analytical framework that bridges waste prioritization with continuous improvement, supported by digital data visualization for enhanced performance monitoring. **Implications** These findings establish a scalable reference model for manufacturing managers to minimize non-value-added activities, optimize production workflows, and achieve measurable efficiency gains through systematic lean application and ongoing process monitoring.

Highlights:

- ♦ Waiting and motion identified as the most significant contributors to production inefficiencies.
- ♦ Integrated lean improvements lead to a 95-minute reduction in total lead time.
- ♦ Standardized work procedures and layout optimization increase process cycle efficiency by over 12%.

Keywords: Kaizen, Lean Manufacturing, Process Activity Mapping, Process Cycle Efficiency, Value Stream Mapping

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Introduction

The manufacturing industry is required to continuously improve efficiency and product quality; however, in practice, production processes still contain various non value added activities that reduce operational effectiveness. In general, these inefficiencies can be classified as waste, which can be defined as activities that consume resources without generating value for the final product [1]. To overcome this problem, organizations often apply lean manufacturing as a systematic method to reduce waste and improve overall production performance through continuous improvement efforts [2]. In addition, several studies have indicated that the integration of lean principles with digital technology can support faster decision-making and provide more accurate production monitoring [3]. To improve production performance, companies need to identify the main sources of inefficiency within the process before applying suitable improvement actions to achieve more optimal production results [4].

PT ABC operates as a manufacturer of plastic sacks, including jumbo bags, with a relatively complex production process and a strong orientation toward export markets. Based on the CVSM analysis, the total production lead time reaches 515 minutes, with 280 minutes categorized as VA activities, resulting in an initial Process Cycle Efficiency (PCE) of 54.37%. During the period from September 2024 to August 2025, the company recorded 3,973 defective units out of a total production of 386,803 units, with 3,909 units requiring rework. These figures indicate that quality issues still occur at a noticeable level. Based on field observations, the most significant waste found in the production process is waiting and motion. Waiting waste mainly happens because machine preheating is not scheduled properly before production starts. Meanwhile, motion waste occurs because the placement of tools and materials in the work area is still not well arranged, causing operators to move back and forth more frequently during production activities. These conditions contribute to longer lead times and can increase overall operational costs.

Lean manufacturing provides a structured method for identifying and minimizing waste within production systems [5]. In this study, (VSM) is used to represent the progression of materials together with related information across the process while distinguishing between VA and NVA activities [6]. Process performance is evaluated using Process Cycle Efficiency (PCE), which compares value-added time with the total lead time [7]. Furthermore, Value Stream Analysis Tools (VALSAT) are applied to determine the most critical waste types and to select suitable analytical techniques [8]. Root cause analysis is then performed using a fishbone diagram to identify contributing factors [9], and improvement initiatives are developed through a Kaizen approach that emphasizes continuous and ongoing improvement [10].

Although Lean Manufacturing has been implemented in many industries, previous studies often discuss tools such as VSM, VALSAT, and Kaizen separately instead of integrating them into one continuous improvement process. Because of this, the relationship between identifying waste, determining priority problems, and evaluating the effectiveness of improvements is often not explained in a comprehensive manner. In many cases, Process Cycle Efficiency (PCE) is also rarely used as a key measurement, even though it can provide a clear picture of the actual efficiency level of a production process. This research applies a more integrated approach by combining VSM, VALSAT, Process Activity Mapping (PAM), and PCE within a single analytical framework. Through this approach, waste identification and improvement efforts can be carried out in a more systematic way, while the impact of the proposed improvements can be measured more clearly. The improvement proposals are developed based on Kaizen principles and supported by a dashboard system, making the results more practical and easier to evaluate, particularly in the jumbo bag production process.

Based on these issues, this study focuses on addressing problems found in the jumbo bag production process at PT ABC through an integrated improvement approach. The objectives of this research are: (1) to evaluate the current production process using Value Stream Mapping (VSM) and measure the Process Cycle Efficiency (PCE); (2) to determine the most dominant types of waste through VALSAT analysis and identify their root causes using a fishbone diagram; and (3) to develop as well as evaluate improvement proposals based on Kaizen principles to enhance the overall efficiency of the jumbo bag production process.

Method

This study applies a quantitative approach through a case study conducted in the jumbo bag production process at PT Kerta Rajasa Raya. The research aims to identify existing waste and develop improvement strategies by implementing an integrated Lean Manufacturing approach. This approach focuses on reducing NVA activities while improving process efficiency through continuous improvement efforts [11].

1. Research Framework

This research follows a systematic sequence of stages. The first stage involves identifying problems and collecting initial data through direct observations and production time measurements. Next, a Current Value Stream Mapping (CVSM) is developed to describe the flow of materials and information, while also separating value-added (VA) and non-value-added (NVA) activities [12]. After that, a seven-waste questionnaire is distributed to operators and supervisors to support the waste identification process. Fourth, the analysis is carried out using Value Stream Analysis Tools (VALSAT) to identify dominant waste and to determine the most appropriate analytical method for further assessment [5]. Fifth, Process Activity Mapping (PAM) is applied to categorize activities into (VA), (NVA), and (NNVA) [13]. Sixth,

root cause analysis is performed using a fishbone diagram to examine factors related to human, machine, method, and environment [14]. Seventh, improvement strategies are developed based on the Kaizen approach, emphasizing continuous improvement to reduce waste and enhance performance [15]. Finally, digital lean tools, namely Looker Studio, are used to present data visualization that facilitates quicker and more accurate decision-making [3]. The overall research procedure is illustrated in Figure 1.

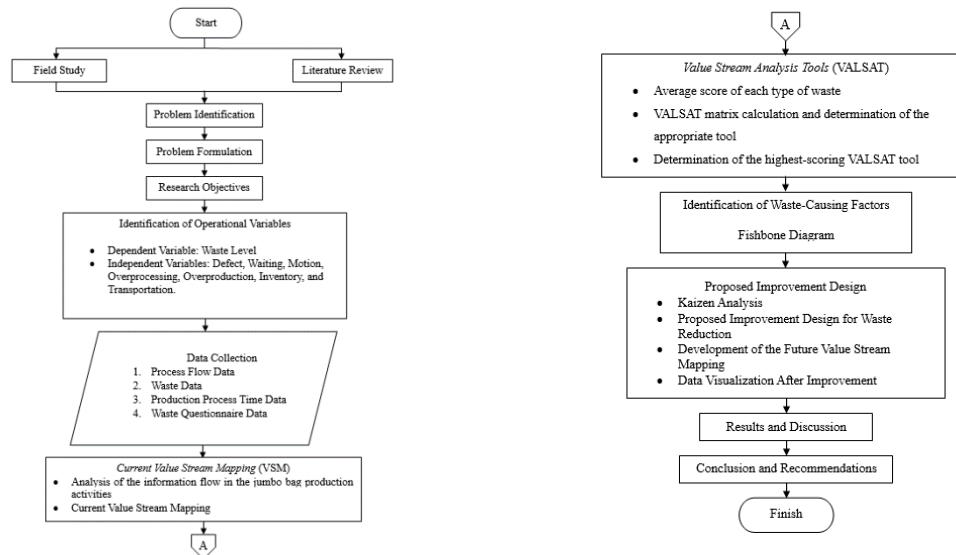


Figure 1. Problem-Solving Steps

2. Variables and Data Collection

This research considers production waste level as the dependent variable, evaluated through the proportion of (NVA) and (NNVA) time observed in the jumbo bag production process. Meanwhile, the independent variables are represented by the seven categories of waste in lean manufacturing, namely defects, overproduction, waiting, motion, transportation, overprocessing, and inventory.

Data used in this study were collected from three main sources:

- Field Observation and Time Measurement: All activities within the jumbo bag production line at PT ABC were directly observed, and process times were recorded to construct an accurate current state Value Stream Map.
- The research instruments include a structured questionnaire, observation sheets, and company production data. The Seven Waste Questionnaire was administered to assess the frequency and impact of each waste category using a Likert scale, and was reviewed to ensure validity and reliability. In this study, the questionnaire was used only as a supporting tool for weighting in Process Activity Mapping (PAM), while waste prioritization was primarily based on actual production data, as it better reflects real conditions.
- Company Documentation: Production records, standard operating procedures, and internal process documents were reviewed to validate the workflow, support time study results, and strengthen the overall data analysis.

3. Data Analysis Techniques

Several analytical techniques are applied in this study, including:

- Value Stream Mapping (VSM) is applied to visualize the flow of materials and information in the production process. This method helps identify (VA), (NVA), and (NNVA) activities, enabling a clear visualization of waste within the system [12].
- Process Cycle Efficiency (PCE) is used to evaluate process efficiency by comparing VA time with total lead time. A higher PCE value reflects a more efficient production process with reduced levels of waste [1].
- VALSAT is utilized to identify the most dominant waste types and to determine the most suitable detailed analysis tool, thereby supporting prioritization in waste reduction initiatives [5].
- PAM is employed to examine each activity in detail by categorizing it into (VA), (NVA), and (NNVA) activities, enabling the identification of inefficiencies and unnecessary steps within the production process [13].
- The fishbone diagram is used to identify the root causes of waste by analyzing contributing factors such as human, machine, method, and environment. This method supports systematic problem identification [14].
- Kaizen is applied as a continuous improvement approach to eliminate waste and enhance production performance. It focuses on incremental improvements based on identified problems in the production process [15].

Results and Discussion

A. Current State Analysis and Waste Identification

To better illustrate how the production activities are carried out, the flow of the jumbo bag production process is shown in Figure 2.

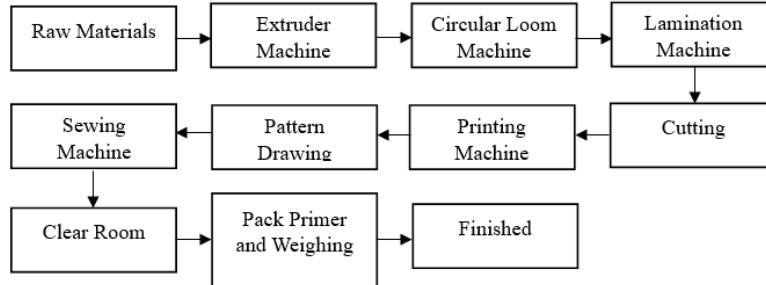


Figure 2. Jumbo Bag Production Process Flow

The production process of jumbo bags at PT ABC begins with raw material processing, which is carried out using an extruder machine to produce plastic yarn. The production process begins with yarn being processed on a circular loom to form tubular fabric. Following this stage, the fabric is processed through lamination to provide an additional protective coating before being cut based on the required size specifications. After the cutting operation, the material moves to the printing process together with the preparation of jumbo bag pattern components. All components are then combined through an industrial sewing process carried out by the operators to form the final product. Lastly, the completed jumbo bags are inspected inside a cleanroom area to verify that the products comply with the established quality standards. In the final stage, the product goes through pack primer processing and weighing before it is declared ready for packaging and distribution. Based on the described production process, the processing time and activity type at each stage are presented in Table 1.

Table 1. Time data and activity types in the jumbo bag production process

No	Activity	Time (Minutes)	Type of Activity	Category
Raw Materials				
1	Raw Material Inspection	10	<i>Inspection</i>	NNVA
2	Penimbangan bahan baku	14	<i>Operation</i>	VA
3	Sending Raw Materials to the Next Process	2	<i>Transportation</i>	NNVA
Extruder Machine				
4	Waiting for Screen Barrel and Screen Pack Heating	30	<i>Delay</i>	NVA
5	Filling Raw Materials into the Hopper	5	<i>Operation</i>	NNVA
6	Melting Plastic Material	10	<i>Operation</i>	VA
7	Extruding Film Sheet	2	<i>Operation</i>	VA
8	Cutting Film into Yarn Tape	10	<i>Operation</i>	VA
9	Winding Yarn onto Bobbins	14	<i>Operation</i>	VA
10	Basic Yarn Inspection	2	<i>Inspection</i>	NNVA
11	Transporting Bobbins to Circular Loom Machine	4	<i>Transportation</i>	NNVA
Circular Loom Machine				
12	Installing Bobbins and Joining Broken Yarn	10	<i>Operation</i>	NNVA
13	Weaving Yarn into Fabric Sheets	30	<i>Operation</i>	VA
14	<i>Machine Setup</i>	3	<i>Operation</i>	NNVA
15	Inspection of Woven Fabric Sheets	3	<i>Inspection</i>	NNVA
16	Transporting Fabric Sheets to the Next Process	4	<i>Transportation</i>	NNVA
Lamination Machine				
17	Waiting for Lamination Machine Heating	25	<i>Delay</i>	NVA
18	Installing Fabric Sheets on the Lamination Machine	10	<i>Operation</i>	NNVA
19	Lamination Process	20	<i>Operation</i>	VA
20	Inspection of Laminated Sheets	3	<i>Inspection</i>	NNVA
21	Transporting Laminated Sheets to the Next Process	2	<i>Transportation</i>	NNVA
Cutting Machine				

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22	Cutting Rolled Fabric Sheets	20	Operation	VA
23	Sending Cut Sheets to the Next Process	2	Transportation	NNVA
Printing Machine				
24	Waiting for Screen Barrel Heating	17	Delay	NVA
25	Changing Lists and Sizes	20	Operation	NNVA
26	Design Printing	30	Operation	VA
27	Drying Printed Sheets	25	Operation	VA
28	Inspection of Printed Sheets	17	Inspection	NNVA
29	Sending Printed Sheets to the Next Process	2	Transportation	NNVA
Pattern Making				
30	Jumbo Bag Pattern Drawing	30	Operation	VA
31	Jumbo Bag Pattern Drawing	25	Operation	VA
32	Sending Patterned Material to the Next Process	2	Transportation	NNVA
Sewing Machine				
33	Sewing Machine Preparation (needle & thread setup)	10	Operation	NNVA
34	Jumbo Bag Sewing	20	Operation	VA
35	Sewing Quality Inspection	3	Inspection	NNVA
36	Sending Sewn Products to the Next Process	3	Transportation	NNVA
Clear Room				
37	Initial Cleaning with Air Blower	3	Operation	VA
38	Further Cleaning with Anti-Static Blower	5	Operation	VA
39	Sending Cleaned Products to the Next Process	2	Transportation	NNVA
Pack Primer				
40	Product Packaging	10	Operation	VA
41	Product Pressing	7	Operation	VA
42	Labeling	5	Operation	VA
43	Weighing	20	Operation	NNVA
44	Sending Packed Products to Warehouse	2	Transportation	NNVA
Finished Goods Warehouse				
45	Arranging and Storing Products in the Warehouse	22	Storage	NNVA
Total		515 Minutes		

As illustrated in Figure 3, the Big Picture Mapping indicates that the total production lead time in the jumbo bag manufacturing process is 515 minutes (30,900 seconds), while the value-added time reaches 280 minutes (16,800 seconds). Activities categorized as (NVA), which contribute to production waste, must be identified and reduced. In contrast, (NNVA) activities should be minimized as much as possible although these activities are required within the process they do not contribute value from the customer's viewpoint. After identifying the time and type of activities at each stage, a more comprehensive view of the production flow is needed to evaluate overall process performance, as presented in Figure 3.

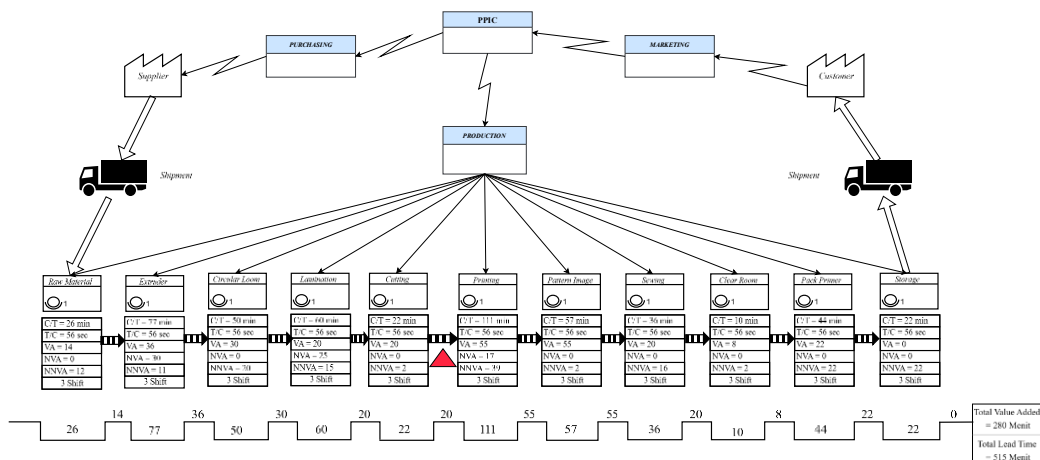


Figure 3. Big Picture Mapping

The current-state VSM indicates that the total production lead time is 515 minutes (30,900 seconds), of which only 280 minutes (16,800 seconds) are classified as value-added activities. This condition results in a PCE of 54.3%. Based on the VALSAT analysis presented in Table 2, Process Activity Mapping (PAM) is considered the most suitable method for detailed waste analysis, with a selection score of 90.2%.

$$\text{Process Cycle Efficiency} = \frac{\text{Value Added}}{\text{Total Lead Time}} = \frac{280}{515} \times 100\% = 54,369\%$$

Table 2. Waste Ranking and Weight

No.	Waste	PAM	SCRM	PVF	QFM	DAM	DPA	PS	Total Score
1	<i>Defect</i>	L	-	-	H	-	-	-	16
2	<i>Waiting</i>	H	H	L	-	M	M	-	75
3	<i>Motion</i>	H	L	-	H	-	-	-	57
4	<i>Overprocessing</i>	H	-	M	L	-	L	-	25,2
5	<i>Overproduction</i>	L	M	-	L	M	M	-	17,6
6	<i>Inventory</i>	M	L	M	-	H	M	L	28
7	<i>Transportation</i>	H	-	-	-	-	-	L	14

Note : H=9 (High), M=3 (Medium), L=1 (Low), - No Corelation

The prominence of waiting and motion waste in this study aligns with the core principles of Lean Manufacturing. According to lean manufacturing principles, activities that do not provide added value, such as delays and excessive movement, can decrease operational efficiency. Waiting waste commonly occurs because the coordination between processes is not well synchronized and scheduling procedures are not properly standardized. On the other hand, motion waste is usually related to ineffective workplace layouts and the absence of clear standardized work methods. The results of this study indicate that both waste types contribute significantly to the increase in production lead time.

After determining the priority of each type of waste, a further analysis is carried out using VALSAT to identify the most appropriate tool, as presented in Table 3.

Table 3. VALSAT Analysis Results

No	Waste	Weight	VALSAT						
			PAM	SCRM	PVF	QFM	DAM	DPA	PS
1	Defect	1,6	1,6	-	-	14,4	-	-	-
2	Waiting	3	27	27	3	-	9	9	-
3	Inventory	3	27	3		27			
4	Overprocessing	1,8	16,2	-	5,4	1,8	-	1,8	-
5	Motion	1,6	1,6	4,8	-	1,6	4,8	4,8	-
6	Transportation	1.4	4,2	1,4	4,2	-	12,6	4,2	1,4
7	Overproduction	1.4	12.6		-				1,4
Total Score		13,8	90,2	36,2	12,6	44,8	26,4	19,8	2,8

Based on the VALSAT evaluation, Process Activity Mapping (PAM) was selected to examine inefficiencies in material and physical flows. This method is intended to reduce NNVA and improve workflow efficiency within the production process. Using this analytical approach, the distribution of activities in terms of both frequency and processing time is presented in Table 4.

Table 4. Percentage of Frequency and Time of Each Activity

No	Activity	Frequency	Percentage	Time (Minutes)	Percentage
1	Operation	25	55,556%	358	69,515%
2	Transportation	10	22,222%	25	4,854%
3	Inspection	6	13,333%	38	7,379%
4	Storage	1	2,222%	22	4,272%

5	Delay	3	6,667%	72	13,981%
	Total	45 Activity	100%	515 Minutes	100%

Based on the information presented in Table 3 and Figure 2, the distribution of activity frequency and processing time in jumbo bag production is dominated by operational activities, which occur 55.556% and a time proportion of 69.515%, transportation activities with a frequency of 22.222% and a time proportion of 4.854%, inspection activities with a frequency of 13.333% and a time proportion of 7.379%, storage activities with a frequency of 2.222% and a time proportion of 4.272%, and delay activities with a frequency of 6.667% and a time proportion of 13.981%.

After identifying the number of activities and the processing time at each stage, all activities were classified into three categories: (VA), (NVA), and (NNVA), as presented in Table 5.

Table 5. Activity Category Frequency and Time Percentage

No	Activity	Frequency	Percentage	Time (Minutes)	Percentage
1	<i>Value Added Activity</i>	18	40%	280	54.369%
2	<i>Non Value Added Activity</i>	3	6.667%	72	13.981%
3	<i>Necessary but Non Value Added Activity</i>	24	53.333%	163	31.650%
	Total	45 Activity	100%	515 Minutes	100%

Based on Table 5 VA activities represent 40% of the total frequency and contribute 54.369% of the total processing time. Meanwhile, NVA activities account for 6.667% of the frequency and 13.981% of the total time. NNVA activities dominate in terms of frequency at 53.333% and contribute 31.650% of the total time. These findings suggest that although non-value-added activities are unavoidable in certain conditions, they should still be minimized to enhance process efficiency.

The results of this study are in line with earlier research showing that waiting and motion are among the most dominant types of waste, mainly caused by poor process coordination and unnecessary operator movement [8],[5]. However, many previous studies were limited to identifying waste without involving digital-based monitoring systems. In this research, digital lean tools are integrated through the use of Looker Studio for data visualization, allowing production performance and waste distribution to be analyzed more clearly and systematically. This approach offers a more practical and measurable basis for supporting continuous improvement efforts.

B. Fishbone Diagram

The analysis of defect-related the analysis of waste in the production process is conducted using a fishbone diagram to identify its root causes, as illustrated in Figure 4.

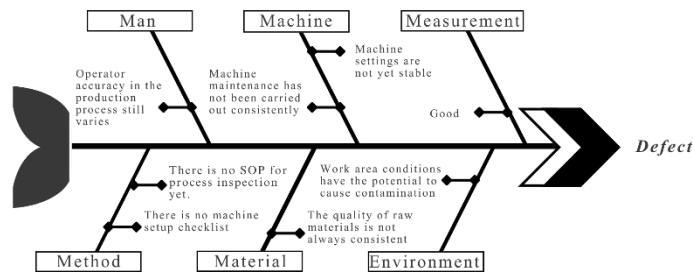


Figure 4. Fishbone Diagram for Defect Waste

Defects in jumbo bag products, such as stitch marks caused by inaccurate sewing, loose weaving from the circular loom machine, and dirt on laminated sheets, reduce both the visual quality and the strength of the product. These conditions increase the likelihood of product rejection or the need for rework, leading to financial losses for the company due to the higher number of defective items and potential delays in delivery.

To further analyze the factors contributing to defect waste, a root cause analysis is performed using a fishbone diagram, as shown in Figure 5.

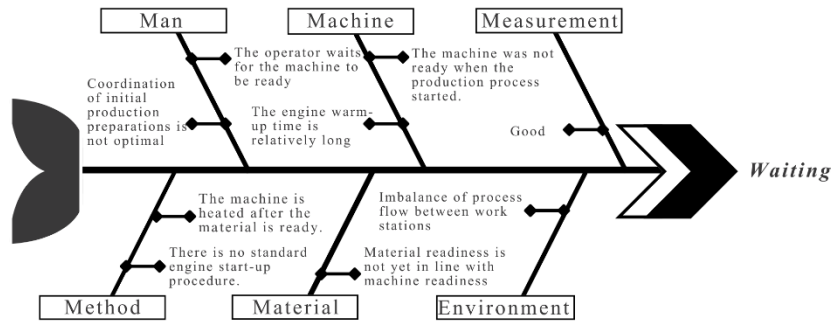


Figure 5. Fishbone Diagram for Waiting Waste

As a result of the Waiting waste, the production process experiences temporary interruptions, slowing down the workflow, reducing operational efficiency, and increasing the risk of delayed product delivery to customers. This condition also decreases the number of products completed on time, thereby affecting overall production performance and the company's operational effectiveness.

To determine the factors contributing to inventory waste in the production process, a root cause analysis is performed using a fishbone diagram, as illustrated in Figure 6.

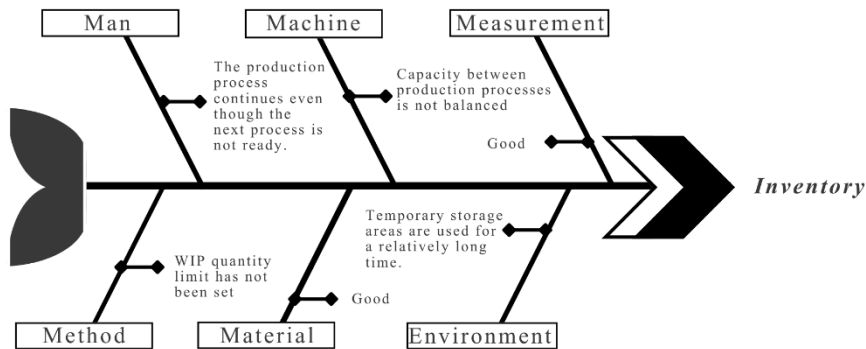


Figure 6. Fishbone Diagram for Inventory Waste

The accumulation of semi-finished products due to imbalanced capacity between processes leads to longer waiting times before materials can proceed to the next stage. This condition may reduce material quality, disrupt the smooth flow of production, and increase storage space requirements, ultimately decreasing process efficiency and adding additional waste for the company.

To determine the factors causing overprocessing in the production process, a root cause analysis is conducted using a fishbone diagram, as presented in Figure 7.

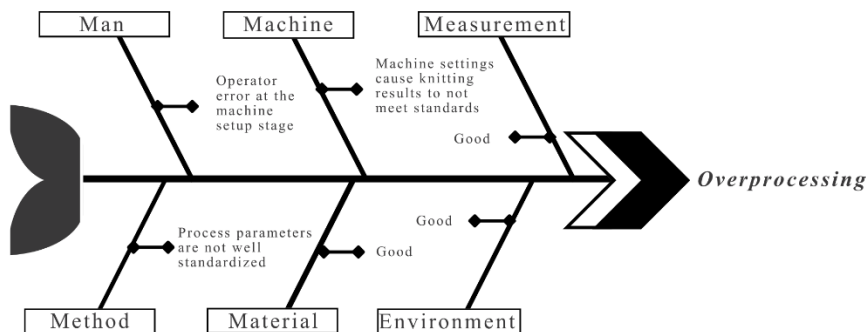


Figure 7. Fishbone Diagram for Overprocessing Waste

Loose fabric weaving produced by the circular loom machine results in product quality that does not meet the required standards, thereby necessitating additional processes and rework. This leads to increased production time, additional labor usage, higher operational costs, and ultimately a reduction in the overall efficiency of the jumbo bag production process.

To examine the causes of excessive and inefficient operator movements in the production process, a root cause analysis is conducted using a fishbone diagram, as illustrated in Figure 8.

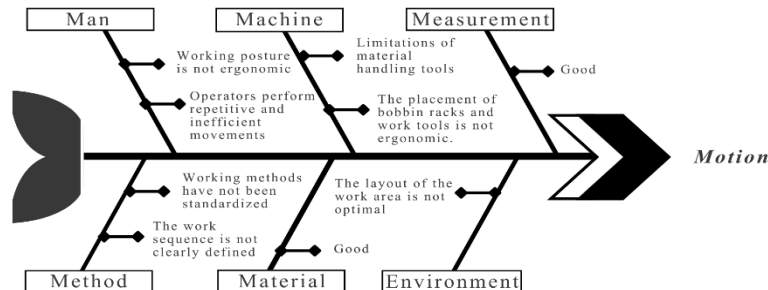


Figure 8. Fishbone Diagram for Motion Waste

Unnecessary motion waste leads to worker fatigue, reduced productivity, and an increased risk of workplace injuries. The efficiency of the production process also declines because moving materials and products takes longer without adequate supporting tools, thereby disrupting the smooth flow of the jumbo bag production process.

To determine the factors causing unnecessary transportation in the production process, a root cause analysis is conducted using a fishbone diagram, as illustrated in Figure 9.

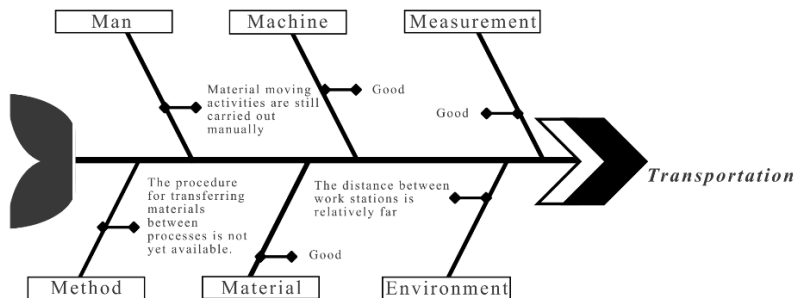


Figure 9. Fishbone Diagram for Transportation Waste

Inefficient transportation increases material handling time and operator workload, thereby extending the production lead time and reducing the efficiency of the jumbo bag manufacturing process.

To determine the factors contributing to overproduction in the production process, a root cause analysis is conducted using a fishbone diagram, as presented in Figure 10.

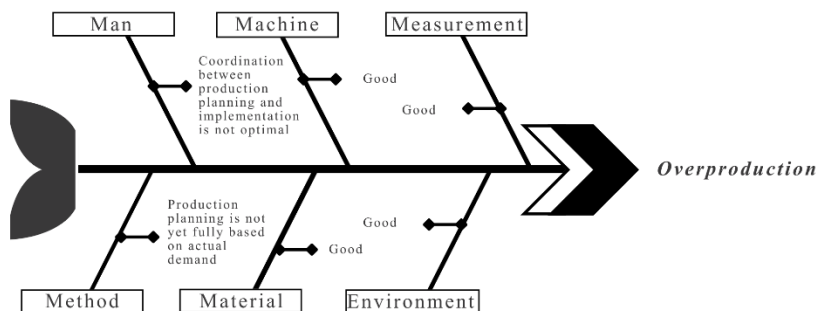


Figure 10. Fishbone Diagram for Overproduction Waste

Overproduction results in the temporary buildup of finished goods in the warehouse, increasing handling activities and storage space requirements, thereby hindering optimal operational efficiency.

C. Kaizen

1. Plan

In the Plan phase, the current production process is analyzed to determine the sources of waste that cause extended lead times and low Process Cycle Efficiency (PCE). This evaluation is conducted using VALSAT, VSM, and PAM, and is then continued with root cause analysis through a fishbone diagram. The analysis results indicate that waiting waste reaches 72 minutes, while motion waste accounts for 60 minutes, making them the two most dominant waste categories in the production process. Based on these results, both wastes are selected as the primary targets for improvement through a Kaizen approach.

2. Do

Based on the identified causes of waiting waste, several improvement proposals are developed to reduce delays in the production process, as presented in Table 6.

Table 6. Kaizen Waiting Improvement Proposal Draft

No	Waiting Activities	Main Problem	Specific Improvement Proposals
1	Waiting for screen barrel & screen pack to warm up	New heating is done after the material is ready.	Design of a machine start-up checklist mechanism as a reference for setting the time and sequence of machine warm-up before the production process.
2	Waiting for the laminating machine to warm up		
3	Waiting for screen barrel (printing) to warm up		

The Kaizen improvement proposed for waiting waste aims to minimize idle time by reorganizing the production schedule and ensuring all processes are ready before production starts. The key adjustment involves rescheduling machine warm up activities, which were previously performed only after materials were available, resulting in unnecessary delays and slowing down the overall production flow.

In addition to waiting waste, improvement proposals are also developed to reduce motion in the production process, as presented in Table 7.

Table 7. Kaizen Motion Improvement Proposal Draft

No	Motion Activities	Main Problem	Specific Improvement Proposals
1	Installing bobbins and connecting broken threads	Repetitive movements during production	Design of spare bobbin arrangement on a vertical rack near the machine to reduce squatting and back and forth
2	Retrieval & installation of needle/thread	Operators go back and forth	Design of a small tool tray on a sewing machine containing needles, thread and scissors
3	Weighing of finished products	Inefficient weighing flow	Design of sewing reset, weigh, store without back and forth movement
4	Change the list and size	There is no standard method and work sequence in the process of replacing lists and sizes so that replacement times are inconsistent and tend to be long.	Designing standard work sequences for list replacement and size and organizing lists based on frequency of use to make the process faster and more consistent.

The Kaizen improvements are mainly directed at reducing motion waste by limiting unnecessary operator movement through improved tool arrangement and a more efficient workflow. With a better-organized work area, operators can perform their tasks without repeatedly moving back and forth during the production process. In addition, work procedures are standardized to make each activity more consistent and efficient. These improvement efforts focus primarily on optimizing workstation layout and organizing supporting tools properly, without involving any changes to the production machines themselves.

3. Check

To evaluate whether the proposed improvements are aligned with the identified root causes, the assessment results are presented in Table 8.

Table 8. Kaizen Improvement Plan Evaluation

Waste Type	Condition Before Repair	Repair Mechanism (Conceptual Proposal)	Forms of Control
Waiting	Waiting for the machine to warm up (screen barrel extruder, screen pack printing and lamination machine)	Machine warm-up is planned to be done at the beginning of the shift before the material arrives.	<i>Machine start-up checklist</i>
Motion	Installing bobbins and connecting broken threads	The bobbin is planned to be positioned near the mounting point.	Bobbin rack near the machine
	Picking up and installing needles and threads	Working tools are combined in one set	<i>Tool tray on the machine</i>
	Weighing of finished products	The workflow is planned to be one-way	Sew, weigh, store sequence
	Change the list and size	The list replacement method is standardized to simplify the work steps.	Standard replacement sequence

The Check phase is carried out to examine whether the proposed Kaizen improvements are in line with the root causes identified during the Plan stage, as well as to evaluate their potential effectiveness from an analytical perspective. At this stage, the research does not yet assess actual implementation outcomes, but instead focuses on determining whether the proposed actions are appropriate for addressing the identified waste problems. For waiting waste, the evaluation emphasizes machine warm-up activities, which are linked to start-up delays caused by the absence of standardized warm-up procedures. Based on this condition, the study considers the implementation of a machine start-up checklist as a logically appropriate solution to address the problem. Overall, this phase ensures that each proposed improvement is not only consistent with the identified root causes but also has a clear potential to reduce waste when viewed from the perspective of workflow analysis.

4. Act

Based on the evaluation results, the improvement actions are formulated to address the identified problems, as presented in Table 9.

Table 9. Kaizen Corrective Action Plan

Main Problem	Proposed Kaizen Recommendation
Long machine preheating time	<i>Machine start-up checklist</i>
Non-standardized list and size changeover method	Standardized work sequence for list and size changeover
Excessive operator movement (motion)	Implementation of fixed locations and simplified work layout

Based on the evaluation results obtained in the Check stage, the Act phase is conducted to formulate improvement recommendations and propose work standardization measures that are suggested for implementation in the next phase of the Kaizen process. This stage serves as a summary and reinforcement of the improvement direction that has been analyzed, rather than as a finalization or confirmation of actual implementation results.

D. Repair Recommendations

The results of the Current Value Stream Mapping and Process Activity Mapping analyses indicate that several activities classified as (NVA) and (NNVA) significantly contribute to the total lead time in the jumbo bag production process. The further analysis focused on activities with the highest time consumption and frequency to ensure that the proposed process adjustments remain realistic. These adjustments form part of the Kaizen improvement proposal aimed at reducing waste and improving overall production flow. To show the impact of the proposed improvements, the adjustments in processing time before and after improvement are presented in Table 10.

Table 10. Jumbo Bag Production Process Time Adjustment

No	Process Description	Processing Time Before Improvement (minutes)	Processing Time After Improvement (minutes)
1	Waiting for screen barrel and screen pack preheating (Extruder Machine)	30	0
2	Waiting for laminating machine preheating	25	0
3	Waiting for screen barrel preheating (Printing Machine)	17	0
4	Bobbin installation and thread splicing	10	6
5	Needle and thread retrieval and installation	10	4
6	Weighing finished products	20	15
7	Changing list and size	20	12

The future state of the production process is illustrated using Big Picture Mapping in Figure 11 to better demonstrate the impact of the proposed improvements on the overall production flow.

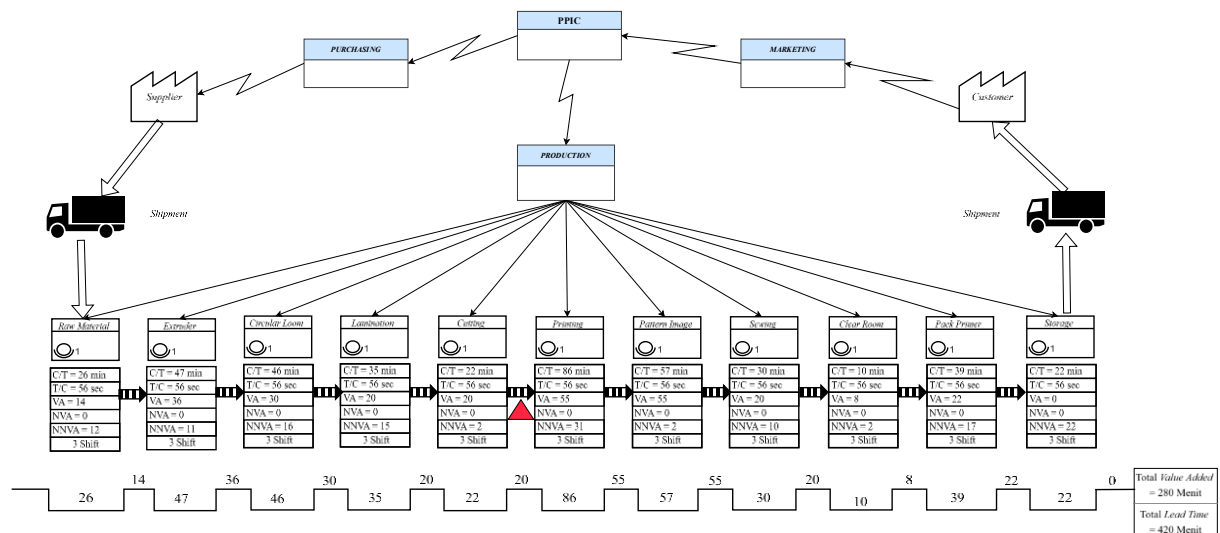


Figure 11. Proposed Big Picture Mapping

Based on the future-state VSM, the total production time of the jumbo bag process is reduced to 420 minutes. Of this total, 280 minutes correspond to VA activities, whereas 140 minutes are classified as (NNVA), and (NVA) activities are identified. This condition indicates that the Kaizen improvement efforts contribute to a more efficient and streamlined production flow. The updated distribution of activities, including their frequency and processing time after improvement, is presented in Table 11.

Table 11. Repair Activity Calculation

No	Activity	Frequency	Percentage	Time (Minutes)	Percentage
1	Operation	25	59,524%	335	79,762%
2	Transportation	10	23,810%	25	5,952%
3	Inspection	6	14,286%	38	9,048%
4	Storage	1	2,381%	22	5,238%
5	Delay	0	0,000%	0	0,000%
	Total	42 Activity	100%	420 Minutes	100%

To evaluate the final impact of the improvements on process efficiency, the classification of activities into VA, NVA, and NNVA added is presented in Table 12.

Table 12. Repair Activity Calculation

No	Activity	Frequency	Percentage	Time (minutes)	Percentage
1	<i>Value Added Activity</i>	18	42,860%	280	54,369%
2	<i>Non Value Added Activity</i>	0	0,000%	0	13,981%
3	<i>Necessary but Non Value Added Activity</i>	24	57,143%	140	31,650%
	Total	42 Activity	100%	420 Minutes	100%

Process Cycle Efficiency (PCE) Calculation

$$\text{Process Cycle Efficiency} = \frac{\text{Value Added}}{\text{Total Lead Time}} = \frac{280}{420} \times 100\% = 66,667\%$$

E. Visualization Looker Studio

To provide a clearer overview of the initial production conditions, the analysis results are visualized using a Looker Studio dashboard, as shown in Figure 12. This visualization helps identify key indicators such as lead time, value added time, and waste distribution.

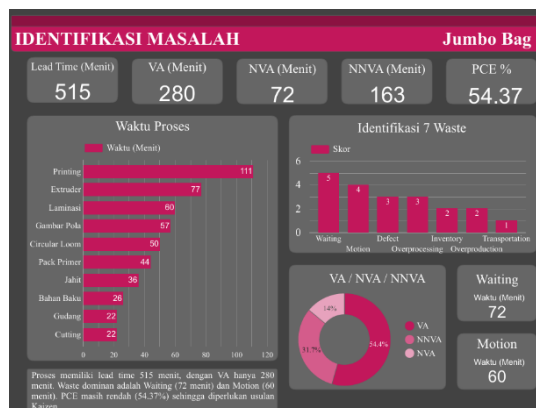


Figure 12. Dashboard Looker Studio

The “Problem Identification” dashboard shows the initial condition of the jumbo bag production process at PT ABC, with a lead time of 515 minutes, 280 minutes of value-added time, and a high portion of NVA and NNVA activities. The PCE of 54.37% indicates low VA contribution. The printing station appears as the longest process, suggesting a potential

bottleneck. The 7 waste analysis identifies Waiting and Motion as the most critical wastes, consuming 72 and 60 minutes respectively. Overall, the main issues are machine waiting times and inefficient operator movements.

To further analyze the production process, the results of VALSAT and PAM are visualized using a Looker Studio dashboard, as shown in Figure 13. This visualization highlights the selected analysis method and the distribution of activities within the process.

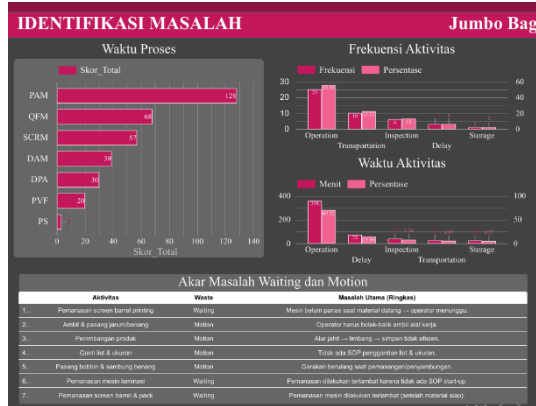


Figure 13. Dashboard Looker Studio

The dashboard displays the outcomes of the VALSAT and PAM evaluations, showing that PAM achieved the highest score and was thus chosen as the main method for analyzing waste in the jumbo bag production process. Frequency and time data reveal that operations are the most dominant activity, while transportation, inspection, and delays remain significant, contributing to extended lead times. The root cause table also identifies several inefficiencies, including delayed machine warm ups, inefficient operator movements, lengthy yarn-joining processes, and a suboptimal sew weigh store workflow.

To show the impact of the proposed improvements, the updated production performance is visualized using a Looker Studio dashboard, as shown in Figure 14. This visualization highlights improvements in lead time and overall process efficiency.

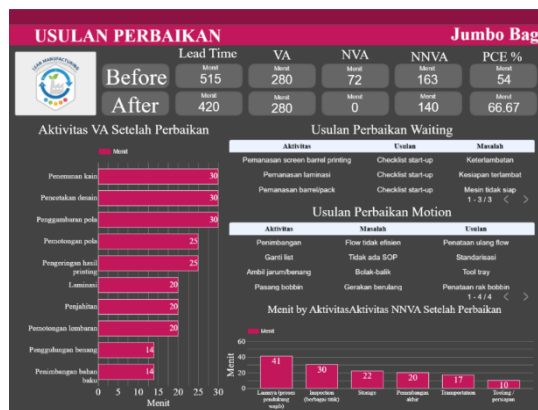


Figure 14. Dashboard Looker Studio

The “Improvement Proposal” dashboard shows process enhancements after addressing the Waiting and Motion wastes at PT ABC. The lead time decreased from 515 to 420 minutes, with value-added time remaining at 280 minutes, NVA eliminated, and NNVA reduced to 140 minutes. The PCE is also projected to increase from 54% to 66.67%. Improvements for Waiting were made through the use of a start-up checklist, while Motion improvements involved reorganizing the workflow, standardizing work methods, implementing tool trays, and arranging bobbin racks. NNVA activities, particularly transportation, weighing, and tool preparation, also showed reductions. Overall, these improvements effectively reduced waiting time and inefficient operator movements.

This study contributes by integrating VSM, VALSAT, PAM, and PCE into a single framework to identify and reduce waste. Unlike previous studies, it links the analysis with Kaizen based improvements and evaluates efficiency quantitatively. In addition, the use of digital visualization through Looker Studio enhances data transparency and supports better decision-making.

This study is limited in that the proposed improvements are based on analytical results and have not been fully implemented in the actual production system. The data are derived from a single case study, which may limit generalization to other industrial contexts. Further research can focus on real implementation and validation in broader production environments.

Conclusions

This study concludes that all seven categories of waste are present in the jumbo bag production process at PT ABC, although their levels vary across activities. Results from the seven-waste questionnaire indicate that waiting and motion (excessive movement) are the most dominant wastes affecting production flow. Based on the initial process mapping, the total lead time is recorded at 515 minutes, of which 280 minutes are identified as value-added activities, yielding a Process Cycle Efficiency (PCE) of 54.37%. Based on the improvement scenario illustrated in the Future State Value Stream Map, the proposed improvements are estimated to reduce the total production lead time to 420 minutes. Along with the decrease in lead time, the Process Cycle Efficiency (PCE) is projected to increase to 66.67%, showing an improvement of around 12.30% compared to the initial production condition.

The proposed waste reduction improvements are developed using a Kaizen-based approach and supported by fishbone analysis to identify the main root causes of the problems. To reduce waiting waste, the study suggests implementing a start-up checklist so that machine preheating can be completed before production activities begin, helping to minimize idle time during the process. Meanwhile, to reduce motion waste, several improvement actions are proposed, such as improving the sling replacement procedure in the printing area, relocating important tools and materials closer to the workstation, and providing tool trays along with layout adjustments to limit unnecessary operator movement. These actions aim to create a more organized and efficient workflow. Overall, the proposed improvements are expected to streamline the production process, reduce excessive workload, and enhance operational performance in jumbo bag manufacturing. From a practical perspective, this study offers a structured approach that manufacturing companies can apply to reduce waste and improve efficiency by integrating VSM, VALSAT, PAM, and Kaizen. For future research, further validation through real implementation is recommended, along with the development of digital-based monitoring systems to support continuous and sustainable improvement.

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